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CORRELATION OF THE CHARACTERISTICS OF SINGLE-CYLINDER AND FLIGHT ENGINES IN TESTS OF HIGH-PERFORMANCE FUELS IN AN AIR-COOLED ENGINE

II - KNOCK-LIMITED CHARGE-AIR FLOW AND CYLINDER TEMPERATURES

By Kenneth D. Brown, Paul H. Richard
and Robert W. Wilson

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NACA

WASHINGTON

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

MEMORANDUM REPORT

for the

Air Technical Service Command, Army Air Forces

CORRELATION OF THE CHARACTERISTICS OF SINGLE-CYLINDER AND FLIGHT ENGINES IN TESTS OF HIGH-PERFORMANCE FUELS IN AN AIR-COOLED ENGINE

II - KNOCK-LIMITED CHARGE-AIR FLOW AND CYLINDER TEMPERATURES

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SUMMARY

An investigation was conducted to correlate the knock-limited performance of flight and single-cylinder engines under a variety of operating conditions. Knock-limited performance of 28-R, triptane blend, and xylidine blend was determined on a full-scale air-cooled single cylinder mounted on a CUE crankcase. The inlet-air temperatures were such that the mixture temperatures were the same as the multicylinder engine with high and low blower ratios.

The single-cylinder engine knock-limited charge-air flow is in good agreement with that of the flight engine for all engine operating conditions tested. Similarly head temperatures for the two engines showed good agreement, but the barrel temperatures for the flight engine were higher than for the single-cylinder engine.

INTRODUCTION

At the request of the Air Technical Service Command, Army Air Forces, tests are being conducted at the Cleveland laboratory of the NACA to evaluate triptane in relation to other high antiknock compounds as a component of aviation fuel. One phase of this program is the correlation of the performance of a full-scale air-cooled single cylinder with that of the same model multicylinder engine in flight in a four-engine airplane.

Part I of this series of reports (reference 1) shows that the cooling characteristics of the flight engine and the single cylinder match for the cylinder heads but differ slightly for the cylinder barrels. The effect of valve clearance on the correlation of the flight and single-cylinder engines knock-limited performance has been investigated and is reported in reference 2. Data obtained during March and April of 1945 are presented herein to show how well the knock-limited performance of three fuels with different temperature sensitivities match in the single-cylinder and multicylinder engines. Data for the multicylinder engine were taken from flight tests of reference 3.

APPARATUS AND TEST PROCEDURE

Single-cylinder engine data were obtained on a full-scale air-cooled cylinder mounted on a CUE crankcase. The arrangement of the setup is shown in figures 1 and 2. This setup is identical with that reported in reference 1. Cylinder and mixture temperatures were measured the same as on the flight engine. (A detailed account of the flight installation and test procedure is presented in the appendix of reference 4.)

These tests were conducted at engine speeds of 1800 and 2250 rpm with spark advances of 25° B.T.C. and 32° B.T.C. and with inlet-air temperatures giving mixture temperatures the same as the multicylinder engine with high and low blower ratios.

The dry inlet-air temperature was held constant in each knock test at a value which gave approximately the same mixture temperature as that obtained with the multicylinder engine for the corresponding test condition.

The data presented in this report are on three fuels: 28-R, a blend of 80 percent 28-R + 20 percent triptane (leaded to 4.6 ml TEL/gal), and a blend of 97 percent 28-R + 3 percent xylidine leaded to 6.0 ml TEL/gal). These percentages are on a volume basis. These fuels will hereinafter be designated 28-R, triptane blend, and xylidine blend.

All data presented herein were run at constant cooling-air pressure drops. The pressure drops on both flight and single-cylinder engines were measured in the same manner. (See reference 4 for flight measurements.) The pressure distribution, however, for the two installations was different and as a result the pressure drop for the single-cylinder engine was higher for the barrel and lower for the head than those used on the flight engine. For the same test condition the over-all average pressure drop of the head and barrel for the two setups was approximately the same.

Knock on both installations was detected by magnetostriction pickups in the cylinder heads and a cathode-ray oscillograph.

The cold valve clearances on the single-cylinder engine were set at a value to give running valve-lift diagrams that closely approximated those specified for the multicylinder engine (reference 2). Multicylinder cold valve clearances were set at the values specified by the engine manufacturer.

RESULTS AND DISCUSSION

A comparison of the knock-limited charge-air flow of 28-R, triptane blend, and xylidine blend fuels on the flight and single-cylinder engine is presented in figure 3. This figure shows that over the range tested speed, spark advance, and inlet-air temperature have no noticeable effect on the matching of the knock-limited charge-air flow. The shape of the curves of charge-air flow for the two engines are the same, the maximum difference being approximately 8 percent. It should be noted that there is better agreement between the two engines with 28-R and triptane-blend fuels than with the more temperature-sensitive xylidine-blend fuel.

The cylinder temperatures of the two engines, in general, show good agreement between the head temperatures but the barrel temperature of the flight engine is considerably higher than for the single-cylinder engine. This result is in agreement with data reported in reference 1.

SUMMARY OF RESULTS

The following results on the knock-limited performance of a full-scale air-cooled single-cylinder engine with three fuels and over a range of speed, spark advance, and inlet-air temperature were obtained.

The single-cylinder engine knock-limited charge-air flow is in good agreement with that of the flight engine. Similarly head temperatures for the two engines showed good agreement, but barrel temperatures for the flight engine were higher than for the single-cylinder engine.

Aircraft Engine Research Laboratory,
National Advisory Committee for Aeronautics,
Cleveland, Ohio, October 12, 1945.

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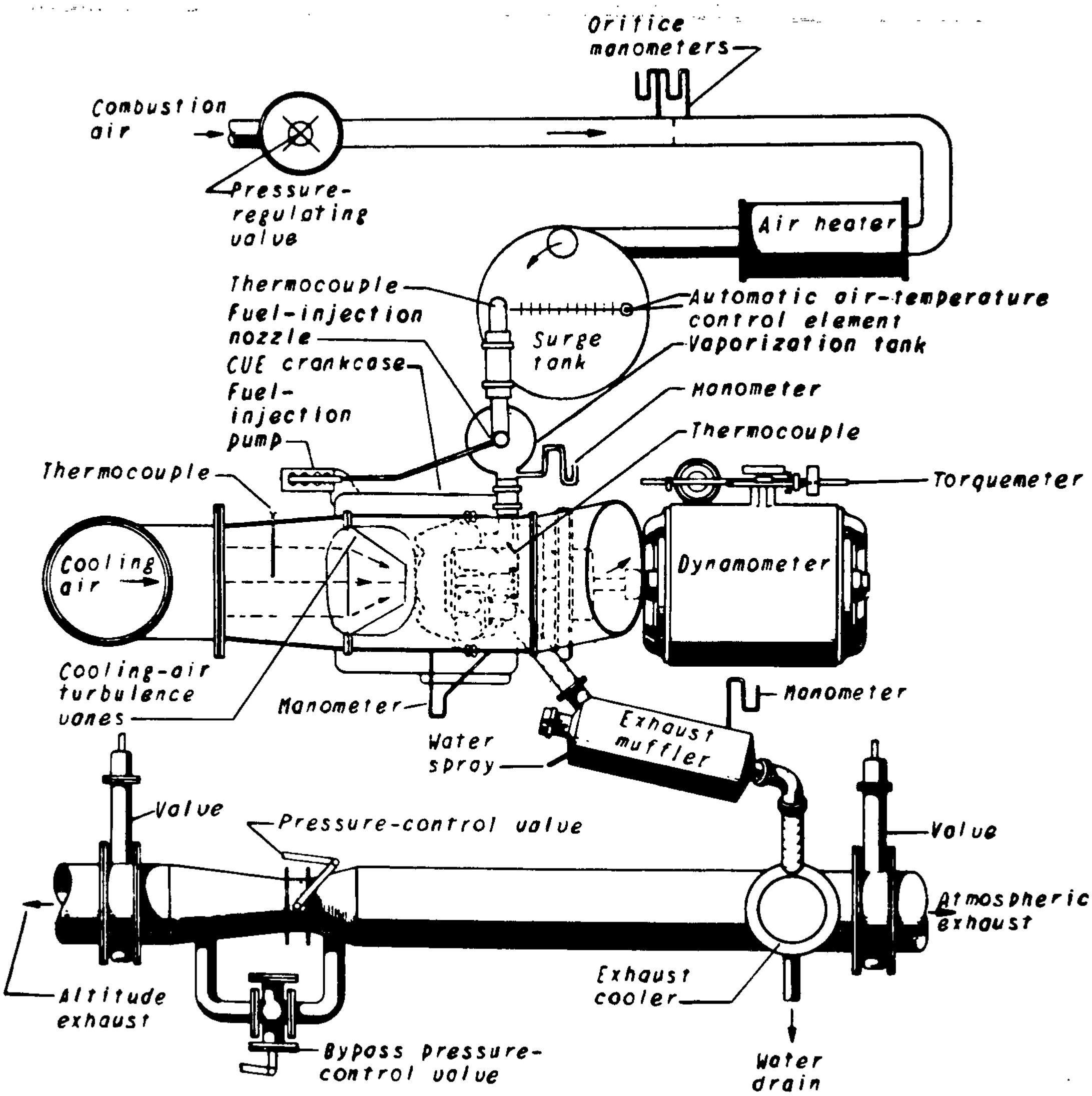

Figure 1. - Air-cooled single-cylinder setup.

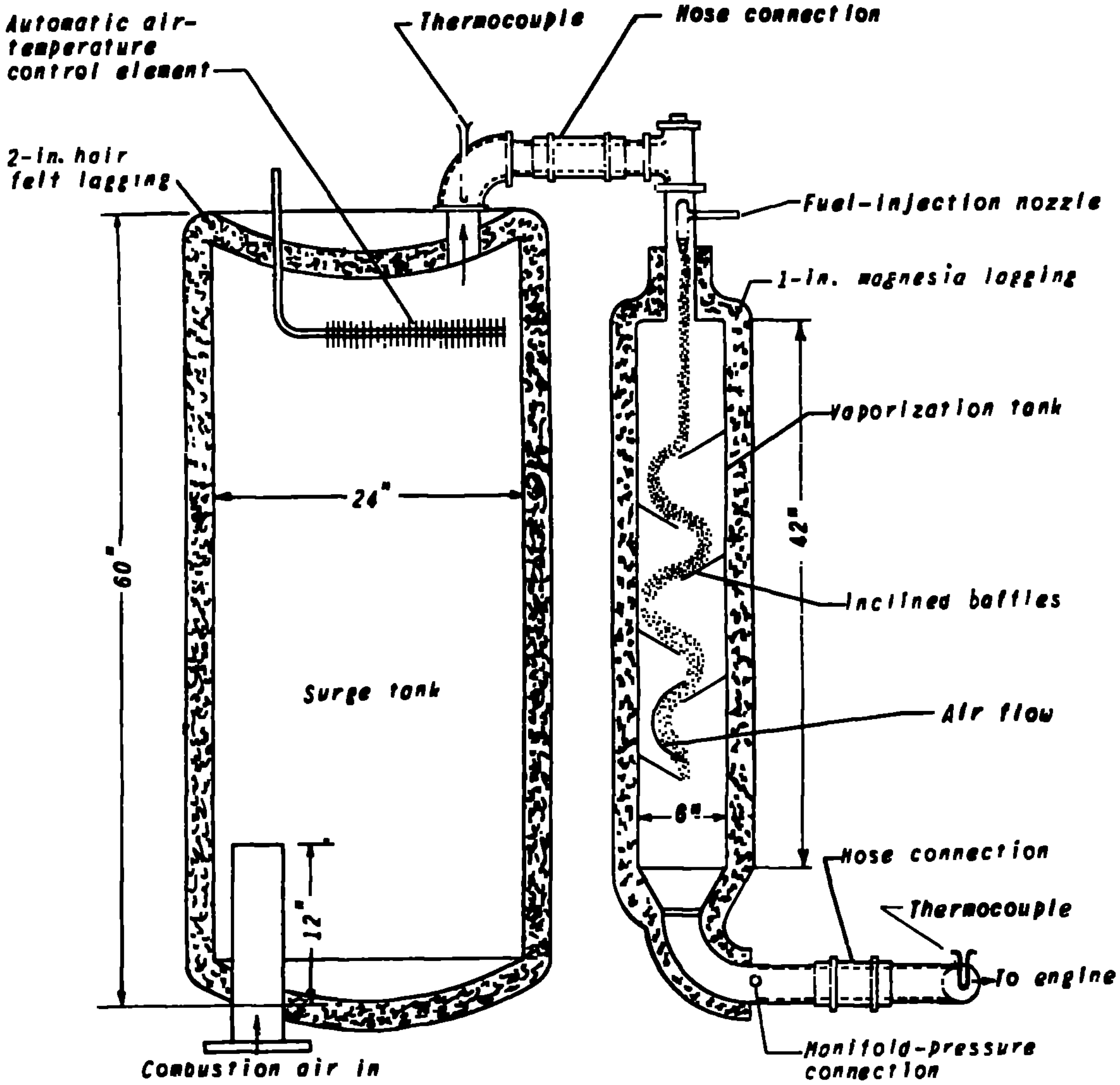

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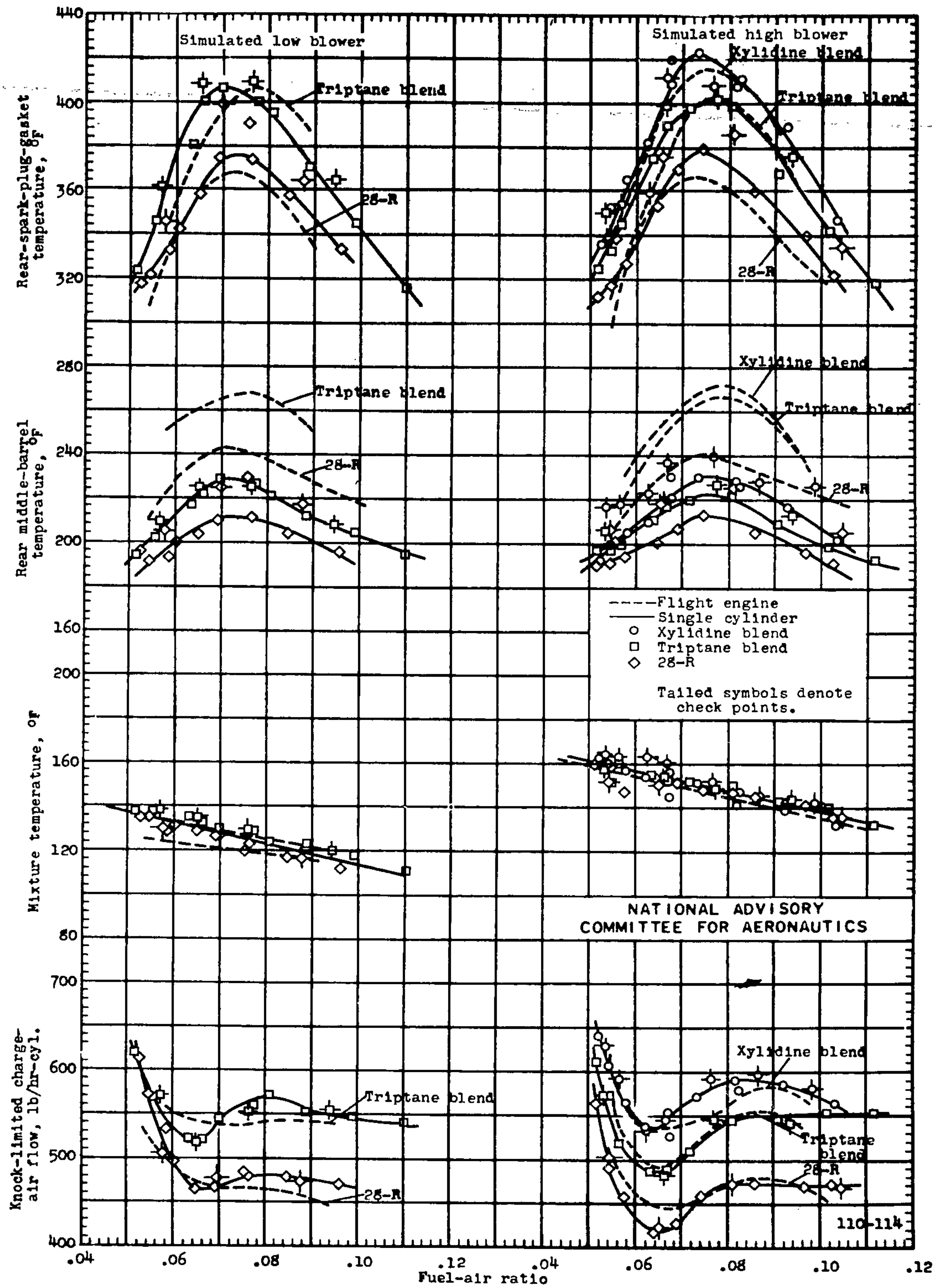
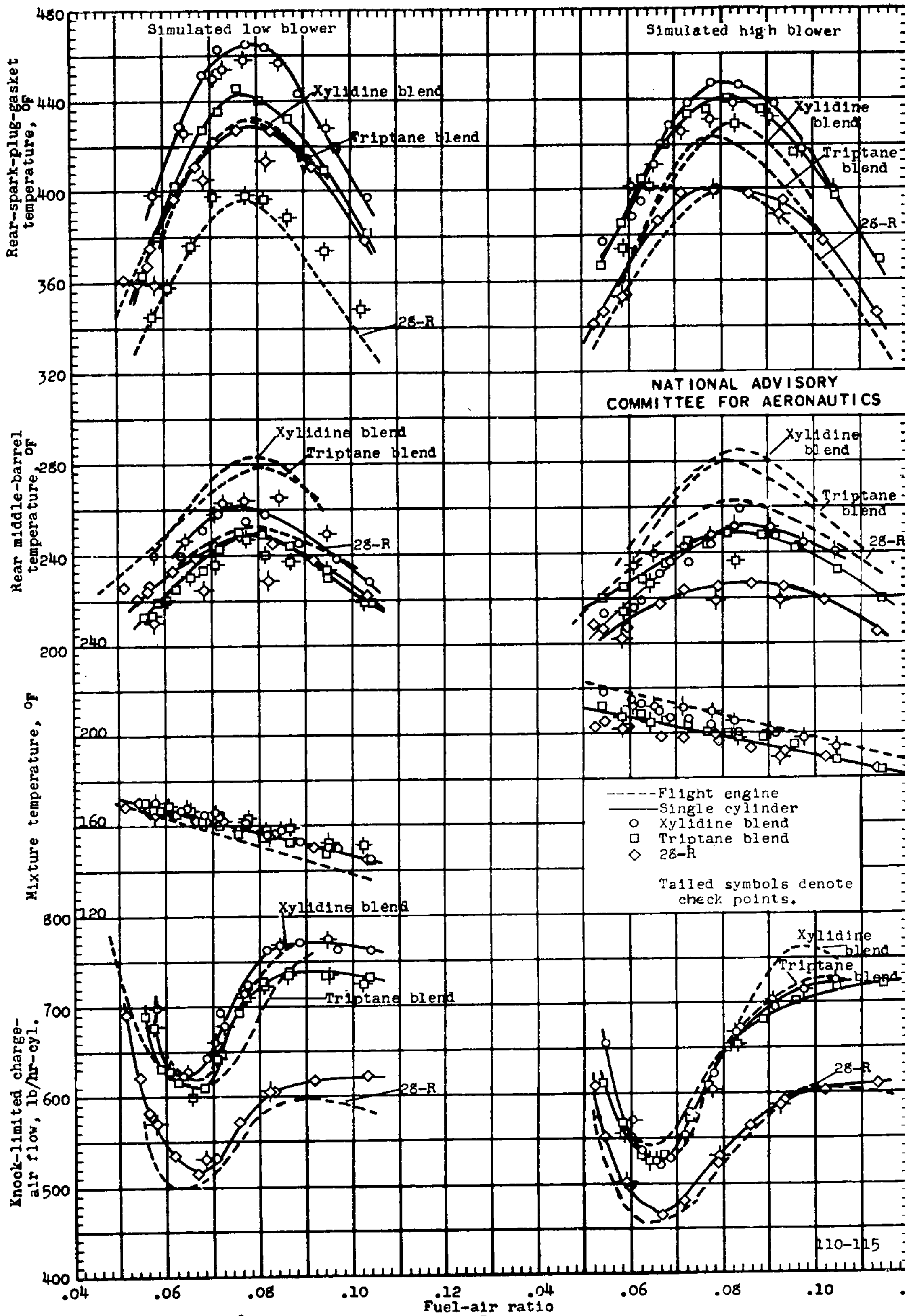
Figure 2. - Induction system used in single-cylinder setup.

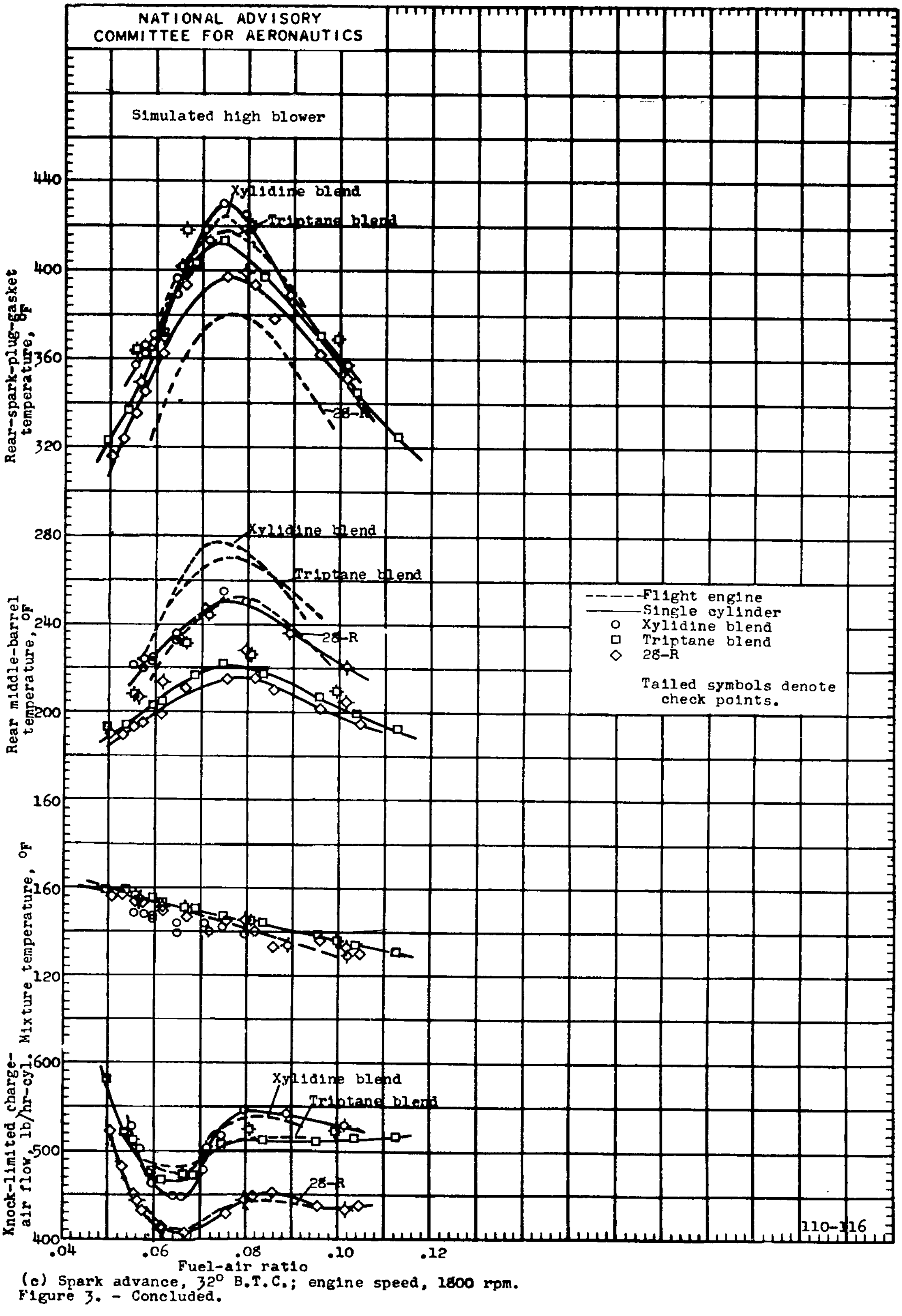


(a) Spark advance, 25° B.T.C.; engine speed, 1800 rpm.

Figure 3. - Comparison of knock-limited charge-air flow, mixture temperature, and cylinder temperatures on flight engine and full-scale single cylinder with three fuels and at constant cooling-air pressure drops. Compression ratio, 6.7.



(b) Spark advance, 25° B.T.C.; engine speed, 2250 rpm.
Figure 3. - Continued.



(c) Spark advance, 32° B.T.C.; engine speed, 1800 rpm.
Figure 3. - Concluded.

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